MIND, BRAIN, AND EDUCATION

Rhythmic Rhymes for Boosting Phonological Awareness in Socially Disadvantaged Children

Sarah E. A. Kuppen[1] and Emilie Bourke[2]

ABSTRACT— This study evaluated the ability for two rhythmic rhyming programs to raise phonological awareness in the early literacy classroom. Year 1 (5–6-year-olds) from low socioeconomic status schools in Bedfordshire, learned a program of sung or spoken rhythmic rhymes, or acted as controls. The project ran with two independent cohorts (Cohort 1 $N=98$, Cohort 2 $N=136$). Program-related gains from pre- to post-tests of phonological awareness (Rhyme Detection, Rhyme Production, and Phoneme Deletion), were statistically significant with the exception of Rhyme Detection in the Spoken group (Cohort 1) and Rhyme Production in the Sung group (Cohort 2). The Spoken program achieved medium and large effect sizes for Cohort 1 on measures of rhyming awareness (although the effect size was small for Cohort 2). Comparatively, the Sung program was associated with smaller effects (small, negligible, or with a small positive effect for Controls) across tasks and cohorts.

Phonological awareness is the ability to detect, segment, and manipulate the sounds in language, at the large (e.g., word/syllable) or small (e.g., phoneme) unit level (Liberman, 1973). Fundamental in learning to read, phonological awareness provides a strong predictor of a child's early literacy development (Melby-Lervåg, Lyster, & Hulme, 2012; Wood & Terrell, 1998). One brain-based theory of dyslexia (Goswami, 2011; Goswami, Power, Lallier, & Facoeotti, 2014, see Ramus et al., 2003 for a review of others) identifies early sensitivity to speech rhythm as a contributory factor in the development of phonological awareness. This theory, a temporal sampling framework, suggests children with reading difficulties demonstrate associated difficulties with the phase locking of neuronal oscillations (repetitive neural activity), to the slow temporal modulations in speech. The framework specifically addresses the rhythmic deficits and poor analysis and perception of the syllable observed in individuals with dyslexia (Leong, Hämäläinen, Soltész, & Goswami, 2011; Poelmans et al., 2011; Thomson & Goswami, 2010).

One practical interpretation of a temporal sampling framework of dyslexia, suggests rhythmic training could benefit poor readers (Bhide, Power, & Goswami, 2013). The current project further investigates this suggestion. The current research asks whether learning rhythmic language, where cues for speech segmentation have been highlighted, could promote phonological awareness. Furthermore, the project investigates whether these programs could benefit all Year 1 readers in classrooms residing in areas of socioeconomic disadvantage. Children from low socioeconomic status (SES) households may have fewer cognitively stimulating experiences, restricted access to educational materials, lower frequency of rich conversational dialogue, and fewer shared reading experiences. Children from low SES families also face a greater risk of developing weak phonological awareness (Mcdowell, Lonigan, & Goldstein, 2007), and are at an increased likelihood of subsequent poor early reading outcomes (Angiulli, Siegel, & Maggi, 2004; Raz & Bryant, 1990).

Prosody, Syllable Stress, and the Segmentation of Speech

Sensitivity to speech rhythm is present from birth (Mehler et al., 1988). By 9 months, infants are aware of prosodic cues, such as stress patterns, and use information such as pausing and durational differences to identify major phrasal

[1]Department of Psychology, Anglia Ruskin University,
[2]Selwyn College, University of Cambridge,

Address correspondence to Sarah E. A. Kuppen, Department of Psychology, Anglia Ruskin University, East Road, Cambridge CB1 1PT, UK; e-mail: sarah.kuppen@anglia.ac.uk

Present address: Emilie Bourke, University College London.

units in speech (Jusczyk et al., 1992). Infants around this age can also use relative lexical stress to identify words that have a stressed syllable followed by an unstressed syllable (the dominant strong–weak pattern in English; such as in the word "*kingdom*"). However, they cannot recognize words with a nondominant weak-strong pattern such as in the word "*guitar*" (Jusczyk, Houston, & Newsome, 1999). This selectivity likely aids speech segmentation, the process of identifying the boundaries between words, syllables, or phonemes. Cutler and Norris (1988), for example, suggest English speakers mark word onset by the presence of strong syllables.

Complementary evidence, highlighting the importance of prosodic cues in speech segmentation, is available from studies of metrical stress, the alternating of strong and weak syllables. Here, children's ability to process words with the natural syllable stress patterns reversed (demonstrating sensitivity to metrical stress), is related to individual differences in phonological awareness (Wood, 2006). Further support for the relationship between sensitivity to metrical stress and segmentation skill is available from event-related potential (ERP) studies in Dutch (Böcker, Bastiaansen, Vroomen, Brunia, & Gelder, 1999) and behavioral studies in Spanish (Sebastian & Costa, 1997).

The common practice of speaking to infants with exaggerated stress and more "extreme", or stretched vowels, provides a naturalistic demonstration of the importance of prosodic cues in the development of phonological awareness. Not only do infants prefer it (Cooper & Aslin, 1994), evidence suggests that infant-directed speech (IDS) may in fact support speech segmentation (Leong, Kalashnikova, Burnham, & Goswami, 2014; Thiessen, Hill, & Saffran, 2005). ERP studies support the linguistic benefits of IDS, with infants demonstrating increased neural activity in regions associated with phonetic encoding (e.g., Zhang et al., 2011).

A Temporal Sampling Framework of Developmental Dyslexia

One explanation of how the brain processes spoken language, suggests neural oscillations package speech information into time-relevant units (Giraud & Poeppel, 2012). Slow theta, and faster gamma oscillatory networks, perform together to encode both phonetic segments (ca. 20–50 Hz) and syllables (ca. 3–10 Hz, Poeppel, 2003). A temporal sampling framework (Goswami et al., 2014) suggests poor temporal sampling at low frequencies (Theta [4–10 Hz] & Delta [1.5–4 Hz]), explains the weak syllable parsing and difficulties with perceiving syllable stress observed in dyslexia (Goswami, Gerson, & Astruc, 2010). According to this framework, individuals with dyslexia possess a deficit in their ability to process changes in amplitude. In particular, this relates to amplitude rise time, which is the rate of onset in the modulation of the amplitude envelope. Amplitude rise time cues the start of the syllable and provides information on syllable stress (Scott, 1998). It also contributes to the perception of speech rhythm more generally and the development of accurate phonological representations (Thomson, Goswami, & Baldeweg, 2008). Many children with poor reading have more difficulty than controls in discriminating amplitude rise time and demonstrate related poor phonological awareness. They may also show difficulties with perceiving duration and pitch, further determinants of perceived syllable stress (examples from behavioral and electroencephalogram [EEG] experimentation, respectively, can be found in Goswami, Fosker, Huss, Mead, & Szűcs, 2011; Hämäläinen, Salminen, & Leppänen, 2013; Kuppen, Huss, Fosker, Fegan, & Goswami, 2011; Kuppen, Huss, & Goswami, 2014; Kuppen & Goswami, 2016; Poelmans et al., 2011; Stefanics et al., 2011; Thomson & Goswami, 2010).

Rhythmic Spoken and Music-Based Interventions for Literacy

Children's engagement with musical activity has repeatedly been reported as conveying literacy benefits (for a meta-analysis, see Gordon, Fehd, & Mccandliss, 2015). While many of these studies concern the learning of a musical instrument, education-based musical interventions often involve singing. Singing is a universal activity which appears spontaneously, in children around the age of 1 (Peretz, Gagnon, Hébert, & Macoir, 2004). Experience of musical rhythm, while less often taught explicitly, is equally ubiquitous. This is also the case for speech rhythm, considered a universal cornerstone in the acquisition of all languages (Langus, Mehler, & Nespor, 2016).

While the singing and speaking of rhythmic rhymes share many features, learning a rhyme does not require the production or matching of a given melody, as necessary for singing. Despite this, the neural networks overlap considerably (Özdemir, Norton, & Schlaug, 2006). While early reports suggested singing was a right lateralized activity (with language on the left), more recent neuroimaging studies report bihemispheric activation for both activities (Peretz et al., 2004; Schlaug, Marchina, & Norton, 2010). It is still unclear whether tune and lyrics are learned and represented separately in the brain (Christiner & Reiterer, 2013).

Sung or spoken rhyming text provides a strong rhythmic structure. A key feature in the current programs is the expectation created by these prosodic regularities, which can provide phonological priming and facilitate word recognition (Chen et al., 2016). In song, EEG studies demonstrate an enhanced linguistic comprehension when patterns of linguistic stress and musical meter align (Gordon, Magne, & Large, 2011).

Intervention studies implicate a causal relationship between training children's sensitivity to rhythm, pitch and melody, and enhanced literacy development (Bolduc, 2009; Gromko, 2005; Overy, 2003; meta-analysis Standley, 2008). Bhide et al. (2013) delivered a rhythmic program including tapping, clapping, and discriminating rhythms to children with poor reading skills. They observed literacy benefits similar to a comparison group receiving an intervention training program in phonological awareness. In another program developed for children with dyslexia (Thomson, Leong, & Goswami, 2013), the impact of rhythm-based training, using speech and nonspeech stimuli, was compared with a second program that focused on phonetic training. Both programs demonstrated medium effect sizes on literacy outcomes. Finally, Degé and Schwarzer (2011) gave German preschool children one of three interventions: a musical program (e.g., singing, drumming, rhythmic exercises, and dancing), a phonological skills intervention (e.g., rhyming exercises, phoneme recognition, and syllable exercises), or a sports program, which functioned as a control. After controlling for age, SES, and intelligence quotient (IQ), pupils in the musical and phonological skills programs showed a significant increase in areas of phonological awareness. The performance of the sports group remained unchanged. While this study suggested that experience with music can support the development of phonological awareness, the mechanism was unclear. Both song and rhythmic learning were potential candidates for driving change.

The Current Project

The current project aimed to offer teachers an early literacy classroom program that was effective, scientifically sound, and experimentally tested. The specific project aims were (1) to use rhythmic sung and spoken rhyming verse to increase phonological awareness and (2) to support Year 1 children attending schools with a high proportion of children eligible for free school meals (a proxy for low SES). The bespoke Sung and Spoken programs used exaggerated rhythmic features. Prosodic expectation was highlighted through the use of repetition (whether using stress, timing, or melody) and facilitated large and small speech unit segmentation. There were two desired outcomes:

1. To test the application of a dyslexia framework to a program that was designed for all Year 1 beginning readers and delivered as part of the standard classroom curriculum.
2. To assess the potential impact of the programs to raise phonological awareness in classrooms where pupils were from an area of socioeconomic disadvantage.

It was predicted that both the Sung and Spoken programs would have medium to large effects on the development of small and large unit phonological awareness compared with Controls.

METHOD

Participants

All participating schools were mixed gender, nonselective schools in Bedfordshire (United Kingdom), as a stipulation of the funding body. All schools had a higher than average number of children receiving free school meals (as detailed in individual Ofsted inspections available online). Previous U.K. analyses indicated that children receiving free school meals are most often members of families claiming income support, and are likely to be one-parent families. Free school meals can be taken as a proxy for a family falling into the bottom quartile of income distribution (Hobbs & Vignoles, 2007).

Representing two individual grant awards, the project ran across two separate intakes of Year 1 children, with one academic year separating the two cohorts (Cohort 1 $M_{age} = 65.71$ months, age range 5–6 years; Cohort 2 $M_{age} = 66.03$ months, age range 5–6 years). In Cohort 1, six classrooms from three schools were each randomly allocated to one of three conditions (three Control, one Spoken and two Sung). In Cohort 2, there were 5 schools and 13 classrooms. Condition allocation was achieved through a random number generator available online. In Cohort 2, the allocation was Sung (four classrooms), Spoken (three classrooms), and Controls (six classrooms). Control children were Year 1 children from participating schools receiving no additional literacy programs. Prior to the initiation of the project, informed parental consent was obtained for pupils to complete the pre- and post-intervention testing. This was achieved through a signed consent letter from home. The total number of children where continued parental consent was given (i.e., parents gave consent over the entire project) in Cohort 1 was 98 and in Cohort 2 was 136. Each cohort consisted of entirely separate samples (i.e., Cohort 2 was not a follow up of Cohort 1 at a later date). Descriptive statistics for each condition are presented by Cohort in Tables 1 and 2.

Intervention Materials

In Cohort 1, the materials consisted of nine rhymes/songs (songs were the spoken rhymes set to music), with two new compositions added for Cohort 2. To develop the program, the first author collaborated with academics from the Faculty of Education at Cambridge University, in addition to one semi-professional and two professional musicians.

Each rhyme/song was built upon common themes from the Year 1 curriculum (e.g. building materials, body parts), with age appropriate vocabulary taken from the 100 highest frequency words in the Child's Printed Word Database. Each written line was short, with the rhyming word placed at the end. The majority of the rhymes used were covered in Phase 5 of "Letters and Sounds" (the U.K. Department for Education and Skills' synthetic phonics program, 2007).

Table 1
Descriptive Statistics by Condition for Cohort 1 ($N = 98$)

	N	*Classrooms*	*Schools*	*Mean age*	*WR*
Sung	47	2	2	65.6 (3.77)	9.34 (3.64)
Spoken	21	1	1	66.1 (3.21)	7.86 (1.77)
Controls	30	3	1	65.43 (3.63)	9.97 (3.32)

Note. Standard deviations are in parentheses. Mean age is in months. WR = scaled score for the Word Reasoning subtest from the WPPSI III

Table 2
Descriptive Statistics by Condition for Cohort 2 ($N = 136$)

	N	*Classrooms*	*Schools*	*Mean age*	*WR*
Sung	42	4	3	65.38 (2.45)	9.83 (3.01)
Spoken	39	3	3	66.62 (3.47)	9.46 (3.32)
Controls	55	6	5	66.11 (3.88)	10.56 (3.47)

Note. Standard deviations are in parentheses. Mean age is in months. WR = scaled score for the Word Reasoning subtest from the WPPSI III

The songs were composed with many segmentation-supporting features and set to either out-of-copyright or bespoke tunes. In many cases, pitch change co-occurred with syllable change or beat and pitch change underlined divisions at the phoneme level. Pauses were inserted at linguistically meaningful places and vowels were emphasized or even elongated in some places.

Spoken rhymes and songs were delivered over compact disc (CD). A professional singer performed both the rhymes and songs. Percussion sticks and actions were used and were replicated consistently across conditions. PowerPoint slides were provided for each rhyme/song, and presented the words in each, with corresponding images. A CD recording and song/rhyme book was provided for each teacher. Worksheets for the Spoken and Sung conditions in Cohort 2 required the teacher to read out the rhyme and complete the phonological-based activities (not provided for Controls) Free access to the project materials is available at www.tunetime.co.uk.

Experimental Materials

Standardized Tests

To assess verbal ability, the Word Reasoning measure from the Wechsler Preschool and Primary Scale of Intelligence-III (Wechsler, 2002) was administered to all children.

Three subtests, appropriate for measuring phonological awareness in 5 and 6-year-olds, were administered from the Phonological Abilities Test (Muter, Hulme & Snowling, 1997). The Rhyme Detection test (internal reliability coefficient, 0.87; test–retest reliability, 0.80) requires children to identify the word that rhymes with the target from a list of three. The Rhyme Production test (0.83; 0.65) taps expressive phonological awareness and asks for children to produce as many words as possible that rhyme with the target in 30 s. The Phoneme Deletion test (0.95; 0.73), requires phonic analysis where children must articulate a word either without its initial (e.g., "*meat*" without the [m]) or final phoneme (e.g., "*meat*" without the [t]).

Phonics Screening Check

As an objective measure of literacy progress, the outcomes from the U.K. government summer phonics screening check were collected. The test contains 20 regular words and 20 pseudowords (the pass mark in the year of collection was 32 out of 40).

Parental Questionnaire

A questionnaire was distributed to parents/carers of all participating children with the goal of controlling for potentially confounding factors. Questions concerned parental educational attainment (highest level achieved), music-related extracurricular activities, whether the child spent time listening to radio or music at home, and the amount of time spent book sharing.

Fidelity of Implementation Interview

The Fidelity of implementation interview (FoII) measures the extent to which an intervention is practised in accordance to the originally envisioned program (Appendix). An end of program FoII was conducted with the class teachers to explore any general issues arising from the project.

Procedure

With the exception of the development of two additional songs and the worksheets, Cohorts 1 and 2 adopted the same procedure in school. A peripatetic music teacher initiated the project with a visit to the classroom teachers to introduce the program of rhymes/songs. Teachers then had the summer period to familiarize themselves with the program.

At the start of the academic year, the research assistant administered the baseline or pre-test phonological awareness assessments and the verbal ability test for the consented sample. The program was then introduced and run for 10 min at the start and end of each day. Each classroom consisted of approximately 30 children. The Spoken and Sung groups received a schedule for delivery that rotated the rhymes/songs so that the children gradually learned the complete repertoire. In both cohorts the program was delivered for 12 weeks (one school term). The phonological tests (see Experimental Materials) were delivered as post-tests at the end of the term. The research assistant also conducted the fidelity of intervention interview at the end of the program and distributed the parental questionnaires.

RESULTS

Descriptive statistics (Tables 1 and 2) show equal ages ($M_{age} = 66$ months) across conditions in both Cohorts 1 and 2. There was no significant difference in Word Reasoning scores across conditions.

A search for outliers using the boxplot function in SPSS Version 20 (released 2011, IBM Corp. IBM SPSS Statistics for Windows, Armonk, NY, US), identified a number of values falling well outside of the interquartile range in terms of the amount of change made. Using a procedure outlined by Pallant (2010), these values were removed (Rhyme Detection—Spoken [$n = 1$], Controls [$n = 1$]; Rhyme Production—Controls [$n = 5$]; Phoneme Deletion—Sung [$n = 1$], Spoken [$n = 1$]).

Statistical Procedure

An exploratory analysis indicated that the data departed significantly from a normal distribution (according to the kurtosis measure, Shapiro–Wilk test and histogram inspection). A nonparametric procedure was therefore undertaken. The current statistical procedure followed the methods of Thomson et al. (2013), who analyzed a similarly characterized intervention dataset. This particular statistical approach was chosen as it offered transparency for the reader, while providing a statistical technique appropriate for the current data.

A series of Kruskal-Wallis one-way analysis of variance tests indicated that there were no statistical differences in baseline measures for Cohort 2. However, in Cohort 1, the Sung group started at a significantly higher level in their Rhyme Detection performance ($X^2 = 11.26$, $p = .00$), than the Spoken group ($Z = -3.18$, $p = .001$), and on Rhyme Production ($X^2 = 7.49$, $p = .02$) the Sung group was significantly higher than the Controls ($Z = -2.61$, $p < .01$).

To specifically examine the change from pre- to post-test, the procedure of Thomson et al. (2013), adapted from Hatcher (2000), was employed. First, a series of Wilcoxon-signed rank tests was carried out for the pre- and post-tests for Cohorts 1 and 2. Because the project cohorts were slightly different from one another (see Procedure section for details), analyses were undertaken individually.

Phonological Awareness Measures

As can be seen in Tables 3 and 4, for the Spoken and Sung groups, the majority of change from pre- to post-test was statistically significant. The exceptions were in Cohort 1 where the Spoken group did not make statistically significant change on the Rhyme Detection test and in Cohort 2, where the Sung group did not make statistically significant change on the Rhyme Production task. In Cohort 2, statistically significant change was also present in the Controls on all the three measures. Effect sizes were calculated to assess whether gains made by the Spoken and Sung groups were larger than the gains made by the Controls. To do this, gain scores of the Controls were subtracted from the gains of the Spoken and Sung group for each measure. In almost all cases, the experimental groups made larger gains compared with the Controls. The exception to this was in Cohort 2, where membership of the Control group was related to a small positive effect on Rhyme Production and Phoneme Deletion, compared to those learning the Sung program. As a final step, the supplementary gain was divided by the standard deviation of the gain for the Control group to achieve the effect size (Hatcher, 2000).

In Cohort 1, there was a large effect of the Spoken program on the Rhyme Production measure, a medium effect on Rhyme Detection and a small effect for Phoneme Deletion. In the Sung group, effects were small or absent across measures; however, it is worth noting that on Rhyme Production this group started from a statistically higher point than the Controls. In Cohort 2, there were again effects of the Spoken program on Rhyme Production and Rhyme Detection, although they were smaller than in Cohort 1. The Sung program in Cohort 2 showed at best a negligible effect on the Rhyme Production and Phoneme Deletion tasks, it was membership of the Control group, which conveyed a positive small effect.

Phonics Screening Check

In Cohort 2, the phonics screening check data were gathered as an objective measure of literacy progress. The mean outcomes by group were highly similar (Spoken mean = 35 [*SD* 7.46], Sung mean = 35 [*SD* 4.38], and Control mean = 34 [*SD* 6.81]), perhaps indicating that the measure was not adequately sensitive.

Table 3
Cohort 1 Performance Across Conditions ($N = 98$)

	Pre-test	*Post-test*	*Wilcoxon test* *Z score*	*P*	*Gains*	*Effect size calculation*	*Effect size Cohen's d*
Spoken group							
Rhyme Detection	4.81 (3.27)	6.00 (3.06)	−1.98	.1	1.25 (2.51)	1.04/2.06	0.50 medium
Rhyme Production	2.05 (2.48)	4.75 (4.60)	−3.01	.0	2.70 (3.54)	1.87/2.20	0.85 large
Phoneme Deletion	6.24 (6.06)	9.40 (5.95)	−4.15	.0	3.47 (3.13)	0.8/3.35	0.24 small
Sung group							
Rhyme Detection	7.51 (3.06)	8.09 (2.70)	−2.61	.01	.67 (1.51)	.46/2.06	0.22 small
Rhyme Production	3.13 (2.79)	4.20 (2.95)	−2.92	.00	1.29 (2.76)	.46/2.20	0.21 small
Phoneme Deletion	5.94 (5.99)	8.27 (5.75)	−5.37	.00	2.55 (3.36)	−.12/3.35	0.04 negl.
Control group							
Rhyme Detection	6.37 (3.00)	6.83 (3.14)	−0.18	.86	.21 (2.06)		
Rhyme Production	1.77 (2.58)	2.79 (3.48)	−1.64	.10	.83 (2.20)		
Phoneme Deletion	5.50 (6.03)	9.00 (5.67)	−3.19	.001	2.67 (3.35)		

Note. Standard deviations are in parentheses. Effect size calculation is gains from experimental groups minus gains from Control group by measure, divided by standard deviation of Control group by measure. negl. = negligible

Parental Questionnaire and Fidelity of Intervention Interviews

The provision of music across primary schools in the United Kingdom is highly variable and depends upon staff musical expertise. In the project schools, the children had little exposure to music within school. Additionally, less than five of the project children took music lessons, were part of a choir or had any exposure to music outside of the classroom. In regards to the fidelity of implementation of interviews, some teachers found it easier to administer the program at the end of the day in a 20-min slot rather than two individual 10-min sessions at the start and end of the day. A statistical analysis indicated no differential outcomes of note for these classrooms.

DISCUSSION

The current project measured the impact of learning a rhythmic rhyming program, either sung or spoken, on the development of small and large unit phonological awareness. The children were in Year 1 in the United Kingdom (5–6 years old), and the project ran for one term over two separate school years. The bespoke rhymes and songs shared many features; in addition to using the same rhymes, they both used repeating rhythmic stress, timing, or melody to underline speech segments at the level of the word, syllable, rhyme, or phoneme.

Overall, the programs demonstrated small to moderate success, with statistically significant gains from pre- to post-task, but without the large effect sizes predicted. The small or even negative effects from the Sung program were particularly counter to expectation. It is often assumed that when content is sung, it is easier to process and retain than its spoken counterpart (Silverman, 2010). This belief explains the pervasive use of the alphabet song in early years classrooms. However, experimental support for this assumption is limited (Racette & Peretz, 2007). When compared to spoken verse, a song offers a plethora of additional features (Racette & Peretz, 2007). For example, there is musical syntax, musical meaning, the details of the melody, and any emotional aspects to consider. Previous research has found that there is a very wide variation in a 5-year-old's ability to match pitches, melodies, and to attend to musical tasks (e.g., matching a pattern of sung notes; White, Sergeant, & Welch, 1996). It may be that the pitch and melody matching involved in the Sung program hindered the desired increased awareness of sublexical segments.

In the current evaluation, the largest observed effects were from the Spoken program on the rhyme awareness tasks. Imaging studies, (e.g., Raizada, Richards, Meltzoff, & Kuhl, 2008) indicate that in order to produce rhyming words, the inferior parietal lobe is recruited. A child holds the target word in phonological working memory and searches a mental lexicon to locate an appropriate rhyme candidate. The intention for the current programs was to highlight the awareness of linguistic segments, and thus facilitate the task of matching and selecting a rhyming word. At this stage, given the mixed results of the current study, and its small scale, the possible discussion of mechanism and efficacy is limited.

Previous research has identified rhyme awareness as a precursor skill for literacy development (Bradley & Bryant, 1983; Bryant, MacLean, Bradley, & Crossland, 1990). Bryant, Bradley, Maclean, and Crossland (1989) saw a far-reaching predictive value for rhyme knowledge and awareness. For example, they demonstrated that children's knowledge of nursery rhymes at 3 years was predictive (after controlling

Table 4
Cohort 2 Performance Across Conditions ($N = 136$)

	Pretest	Post-test	Wilcoxon test Z score	P	Gains	Effect size calculation	Effect size Cohen's d
Spoken group							
Rhyme Detection	5.13 (3.51)	6.69 (2.88)	−3.65	.00	1.56 (2.60)	0.69/2.07	0.33 small
Rhyme Production	1.85 (2.53)	2.92 (2.93)	−2.62	.01	1.08 (2.34)	0.37/2.02	0.18 small
Phoneme Deletion	4.74 (6.19)	7.59 (5.74)	−3.53	.00	2.85 (4.52)	0.07/4.33	0.02 negl.
Sung group							
Rhyme Detection	5.60 (3.08)	6.56 (2.95)	−2.59	.01	1.00 (2.24)	0.13/2.07	0.06 negl.
Rhyme Production	2.24 (2.99)	2.63 (3.00)	−1.22	.22	0.46 (2.17)	−0.25/2.02	0.14 small positive effect for Controls
Phoneme Deletion	5.21 (5.24)	7.15 (5.40)	−2.61	.01	2.02 (5.48)	−0.76/4.33	0.18 small positive effect for Controls
Control group							
Rhyme Detection	6.02 (2.78)	6.89 (3.07)	−2.94	.00	0.87 (2.07)		
Rhyme Production	1.87 (2.23)	2.81 (3.17)	−2.60	.01	0.71 (2.02)		
Phoneme Deletion	4.41 (5.36)	7.19 (5.57)	−4.07	.00	2.78 (4.33)		

Note. Standard deviations are in parentheses. Effect size calculation is gains from experimental group minus gains from Control group by measure, divided by standard deviation of Control group by measure. negl. = negligible

for baseline rhyme sensitivity, IQ, British Picture Vocabulary Scale, and mother's education) of word reading at age 6. Meta-analyses have also indicated a modest predictive role for rhyme awareness in subsequent literacy development (Melby-Lervåg et al., 2012) and intervention studies corroborate this. For example, studies with both preschool (Harper, 2011) and kindergarten children (Bolduc & Lefebvre, 2012), support the teaching of nursery rhymes for developing phonological awareness.

In conclusion, the current project has been moderately successful in applying the principles of a dyslexia framework to the development of a classroom program for supporting phonological awareness. The learning of our spoken rhythmic rhymes may boost phonological awareness for Year 1 in schools where a high proportion of students are eligible for free school meals. Children from low SES families face a greater risk of developing poor phonological awareness (Mcdowell et al., 2007), and thus comprise an important group for targeted literacy intervention. The results presented here suggest learning spoken rhythmic rhymes could support the foundation skills for subsequent reading development.

Acknowledgment—This research was supported by a grant from the Harpur Trust harpurtrust.org.uk. Thank you to all the schools who took part.

APPENDIX

Cohort 2 involved the collection of Phonics Screening Check data, subsequent to the running of the project. These data were absent at Cohort 1. Additionally, a supplementary Control, where the teacher would administer the worksheets only, was envisioned for Cohort 2. Unfortunately, because of poor administration, this had to be abandoned.

Fidelity to Intervention Interview—According to O'Donnell (2008), there are five dimensions of fidelity; general adherence, adherence to duration, participant responsiveness, quality of delivery, and program differentiation.

REFERENCES

Angiulli, A. D., Siegel, L. S., & Maggi, S. (2004). Literacy instruction, SES, and word-reading achievement in English-language learners and children with English as a first language: A longitudinal study. *Learning Disabilities Research and Practice*, *19*(4), 202–213. https://doi.org/10.1111/j.1540-5826.2004.00106.x

Bhide, A., Power, A., & Goswami, U. (2013). A rhythmic musical intervention for poor readers: A comparison of efficacy with a letter-based intervention. *Mind, Brain, and Education*, *7*(2), 113–123. https://doi.org/10.1111/mbe.12016

Böcker, K. B. E., Bastiaansen, M. C. M., Vroomen, J., Brunia, C. H. M., & Gelder, B. D. E. (1999). An ERP correlate of metrical stress in spoken word recognition. *Psychophysiology*, *36*, 706–720. https://doi.org/10.1111/1469-8986.3660706

Bolduc, J. (2009). Effects of a music programme on kindergartners' phonological awareness skills. *International Journal of Music Education*, *27*(1), 37–47. https://doi.org/10.1177/0255761408099063

Bolduc, J., & Lefebvre, P. (2012). Using nursery rhymes to foster phonological and musical processing skills in kindergarteners. *Creative Education*, *3*(4), 495–502. https://doi.org/10.4236/ce.2012.34075

Bradley, L., & Bryant, P. (1983). Categorizing sounds and learning to read—A causal connection. *Nature*, *301*(3), 419–421. https://doi.org/10.1038/301419a0

Bryant, P., Bradley, L., Maclean, M., & Crossland, J. (1989). Nursery rhymes, phonological skills and reading. *Journal of Child Language*, *16*(2), 407–428. https://doi.org/10.1017/S0305000900010485

Bryant, P. E., MacLean, M., Bradley, L. L., & Crossland, J. (1990). Rhyme and alliteration, phoneme detection, and learning to read. *Developmental Psychology*, *26*(3), 429–438. https://doi.org/10.1037//0012-1649.26.3.429

Chen, Q., Zhang, J., Xu, X., Scheepers, C., Yang, Y., & Tanenhaus, M. K. (2016). Prosodic expectations in silent reading: ERP evidence from rhyme scheme and semantic congruence in classic Chinese poems. *Cognition*, *154*, 11–21. https://doi.org/10.1016/j.cognition.2016.05.007

Christiner, M., & Reiterer, S. M. (2013). Song and speech: Examining the link between singing talent and speech imitation ability. *Frontiers in Psychology*, *4*.

Cooper, R. P., & Aslin, R. N. (1994). Developmental differences in infant attention to the spectral properties of infant-directed speech. *Child Development*, *65*, 1663–1677.

Cutler, A., & Norris, D. (1988). The role of strong syllables in segmentation for lexical access. *Journal of Experimental Psychology: Human Perception and Performance*, *14*(1), 113–121. https://doi.org/10.1037/0096-1523.14.1.113

Degé, F., & Schwarzer, G. (2011). The effect of a music program on phonological awareness in preschoolers. *Frontiers in Psychology*, *2*(June), 124. https://doi.org/10.3389/fpsyg.2011.00124

Giraud, A. L., & Poeppel, D. (2012). Cortical oscillations and speech processing: Emerging computational principles and operations. *Nature Neuroscience*, *15*(4), 511–517. https://doi.org/10.1038/nn.3063

Gordon, R. L., Fehd, H. M., & McCandliss, B. D. (2015). Does music training enhance literacy skills? A meta-analysis. *Frontiers in Psychology*, *6*.

Gordon, R. L., Magne, C. L., & Large, E. W. (2011). EEG correlates of song prosody: A new look at the relationship between linguistic and musical rhythm. *Frontiers in Psychology*, *2*(352). https://doi.org/10.3389/fpsyg.2011.00352

Goswami, U. (2011). A temporal sampling framework for developmental dyslexia. *Trends in Cognitive Sciences*, *15*(1), 3–10. https://doi.org/10.1016/j.tics.2010.10.001

Goswami, U., Fosker, T., Huss, M., Mead, N., & Szűcs, D. (2011). Rise time and formant transition duration in the discrimination of speech sounds: The Ba-Wa distinction in developmental dyslexia. *Developmental Science*, *14*(1), 34–43. https://doi.org/10.1111/j.1467-7687.2010.00955.x

Goswami, U., Gerson, D., & Astruc, L. (2010). Amplitude envelope perception, phonology and prosodic sensitivity in children with developmental dyslexia. *Reading and Writing*, *23*, 995–1019. https://doi.org/10.1007/s11145-009-9186-6

Goswami, U., Power, A., Lallier, M., & Facoeotti, A. (2014). Oscillatory "temporal sampling" and developmental dyslexia: Toward an over-arching theoretical framework. *Frontiers in Human Neuroscience*, *8*, 1–3. https://doi.org/10.1038/nn.3063

Gromko, J. (2005). The effect of music on phonemic awareness in beginning readers. *Journal of Research in Music Education*, *53*(3), 199–209.

Hämäläinen, J., Salminen, H. K., & Leppänen, P. H. T. (2013). Basic auditory processing deficits in dyslexia: Systematic review of the behavioral and event-related potential/field evidence. *Journal of Learning Disabilities*, *46*(5), 413–427. https://doi.org/10.1177/0022219411436213

Harper, L. J. (2011). Nursery rhyme knowledge and phonological awareness in preschool children. *Journal of Language and Literacy Education*, *7*(1), 65–78.

Hatcher, P. J. (2000). Reading intervention need not be negligible: Response to Cossu (1999). *Reading and Writing*, *13*, 349–355.

Hobbs, G., & Vignoles, A. (2007) *Is free school meal status a valid proxy for socio-economic status (in schools research)?* London, England: Centre for the Economics of Education, London School of Economics and Political Science.

Jusczyk, P. W., Hirsh-Pasek, K., Kemler Nelson, D. G., Kennedy, L., Woodward, A., & Piwoz, J. (1992). Perception of acoustic correlates of major phrasal units by young infants. *Cognitive Psychology*, *24*, 252–293.

Jusczyk, P. W., Houston, D. M., & Newsome, M. (1999). The beginnings of word segmentation in English-learning infants. *Cognitive Psychology*, *39*(3–4), 159–207. https://doi.org/10.1006/cogp.1999.0716

Kuppen, S., Huss, M., Fosker, T., Fegan, N., & Goswami, U. (2011). Basic auditory processing skills and phonological awareness in low-IQ readers and typically developing controls. *Scientific Studies of Reading*, *15*(6), 559–559. https://doi.org/10.1080/10888438.2011.622622

Kuppen, S., Huss, M., & Goswami, U. (2014). A longitudinal study of basic auditory processing and phonological skills in children with low IQ. *Applied Psycholinguistics*, *35*(6), 1109–1141.

Kuppen, S., & Goswami, U. (2016). Developmental trajectories for children with dyslexia and low IQ poor readers. *Developmental Psychology*, *52*(5), 717.

Langus, A., Mehler, J., & Nespor, M. (2016). Rhythm in language acquisition. *Neuroscience and Biobehavioral Reviews*. https://doi.org/10.1016/j.neubiorev.2016.12.012

Leong, V., Hämäläinen, J., Soltész, F., & Goswami, U. (2011). Rise time perception and detection of syllable stress in adults with developmental dyslexia. *Journal of Memory and Language*, *64*(1), 59–73. https://doi.org/10.1016/j.jml.2010.09.003

Leong, V., Kalashnikova, M., Burnham, D., & Goswami, U. (2014). Infant-directed speech enhances temporal rhythmic structure in the envelope. In *Fifteenth Annual Conference of the International Speech Communication Association*.

Liberman, I. (1973). Segmentation of the spoken word and reading acquisition. *Bulletin of The Orton Society*, *23*, 65–76.

Mcdowell, K. D., Lonigan, C., & Goldstein, H. (2007). Relations among socioeconomic status, age, and predictors of phonological awareness. *Journal of Speech, Language, and Hearing Research*, *50*(August), 1079–1092.

Mehler, J., Jusczyk, P., Lambertz, G., Halsted, N., Bertoncini, J., & Amiel-Tison, C. (1988). A precursor of language acquisition in young infants. *Cognition*, *29*, 143–178.

Melby-Lervåg, M., Lyster, S.-A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: A meta-analytic review. *Psychological Bulletin*, *138*(2), 322–352. https://doi.org/10.1037/a0026744

Muter, V., Hulme, C., & Snowling, M. (1997). *Phonological Abilities Test*. London: Psychological Corporation.

O'Donnell, C. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K-12 curriculum intervention research. *Review of Educational Research*, *78*(1), 33–84. https://doi.org/10.3102/0034654307313793

Overy, K. (2003). Dyslexia and music: From timing deficits to musical intervention. *Annals of the New York Academy of Sciences*, *999*, 497–505. https://doi.org/10.1196/annals.1284.060

Özdemir, E., Norton, A., & Schlaug, G. (2006). Shared and distinct neural correlates of singing and speaking. *NeuroImage*, *33*(2), 628–635. https://doi.org/10.1016/j.neuroimage.2006.07.013

Pallant, J. (2010) *SPSS: Survival Manual*. Maidenhead, England: Open University Press.

Peretz, I., Gagnon, L., Hébert, S., & Macoir, J. (2004). Singing in the brain: Insights from cognitive neuropsychology. *Music Perception*, *21*(3), 373–390.

Poelmans, H., Luts, H., Vandermosten, M., Boets, B., Ghesquière, P., & Wouters, J. (2011). Reduced sensitivity to slow-rate dynamic auditory information in children with dyslexia. *Research in Developmental Disabilities*, *32*(6), 2810–2819. https://doi.org/10.1016/j.ridd.2011.05.025

Poeppel, D. (2003). The analysis of speech in different temporal integration windows: Cerebral lateralization as "asymmetric sampling in time". *Speech Communication*, *41*, 245–255. https://doi.org/10.1016/S0167-6393(02)00107-3

Racette, A., & Peretz, I. (2007). Learning lyrics: To sing or not to sing. *Memory & Cognition*, *35*(2), 242–253.

Raizada, R., Richards, T., Meltzoff, A., & Kuhl, P. (2008). Socioeconomic status predicts hemispheric specialisation of the left inferior frontal gyrus in young children. *NeuroImage*, *40*(3), 1392–1401. https://doi.org/10.1016/j.neuroimage.2008.01.021.Socioeconomic

Ramus, F., Rosen, S., Dakin, S. C., Day, B. L., Castellote, J. M., White, S., & Frith, U. (2003). Theories of developmental dyslexia: Insights from a multiple case study of dyslexic adults. *Brain*, *126*, 841–865. https://doi.org/10.1093/brain/awg076

Raz, I. S., & Bryant, P. (1990). Social background, phonological awareness and children's reading. *British Journal of Developmental Psychology*, *8*(3), 209–225. https://doi.org/10.1111/j.2044-835X.1990.tb00837.x

Schlaug, G., Marchina, S., & Norton, A. (2010). From singing to speaking: Why singing may lead to recovery of expressive language function in patients with Broca's aphasia. *National Institutes of Health*, *25*(4), 315–323. https://doi.org/10.1525/MP.2008.25.4.315.From

Scott, S. K. (1998). The point of P-centres. *Psychological Research*, *61*, 4–11.

Sebastian, N., & Costa, A. (1997). Metrical information in speech segmentation in Spanish. *Language and Cognitive Processes*, *12*(5–6), 883–887. https://doi.org/10.1080/016909697386781

Silverman, M. J. (2010). The effect of pitch, rhythm, and familiarity on working memory and anxiety as measured by digit recall performance. *Journal of Music Therapy*, *1*, 70–83.

Standley, J. (2008). Does music instruction help children learn to read? Evidence of a meta-analysis. *Applications of Research in Music Education*, *27*(1), 17–32. https://doi.org/10.1177/8755123308322270

Stefanics, G., Fosker, T., Huss, M., Mead, N., Szucs, D., & Goswami, U. (2011). Auditory sensory deficits in developmental dyslexia: A longitudinal ERP study. *NeuroImage*, *57*(3), 723–732. https://doi.org/10.1016/j.neuroimage.2011.04.005

Thiessen, E. D., Hill, E. a., & Saffran, J. R. (2005). Infant-directed speech facilitates word segmentation. *Infancy*, *7*(1), 53–71. https://doi.org/10.1207/s15327078in0701_5

Thomson, J., & Goswami, U. (2010). Learning novel phonological representations in developmental dyslexia: Associations with basic auditory processing of rise time and phonological awareness. *Reading and Writing*, *23*, 453–473. https://doi.org/10.1007/s11145-009-9167-9

Thomson, J. M., Goswami, U., & Baldeweg, T. (2008). The ERP signature of sound rise time changes. *Brain Research*, *1254*, 74–83. https://doi.org/10.1016/j.brainres.2008.11.087

Thomson, J. M., Leong, V., & Goswami, U. (2013). Auditory processing interventions and developmental dyslexia: A comparison of phonemic and rhythmic approaches. *Reading and Writing*, *26*(2), 139–161. https://doi.org/10.1007/s11145-012-9359-6

Wechsler, D. (2002). *WPPSI-III Administration and Scoring Manual*. San Antonio, TX: Psychological Corporation.

White, P. J., Sergeant, D. C., & Welch, G. F. (1996). Some observations on the singing development of five-year-olds. *Early Child Development and Care*, *118*(1), 27–34.

Wood, C. (2006). Metrical stress sensitivity in young children and its relationship to phonological awareness and reading. *Journal of Research in Reading*, *29*(3), 270–287. https://doi.org/10.1111/j.1467-9817.2006.00308.x

Wood, C., & Terrell, C. (1998). Preschool phonological awareness and subsequent literacy development. *Educational Psychology*, *18*(3), 253–274. https://doi.org/10.1080/0144341980180301

Zhang, Y., Koerner, T., Miller, S., Grice-patil, Z., Akbari, D., Tusler, L., & Carney, E. (2011). Neural coding of formant-exaggerated speech in the infant brain. *Developmental Science*, *3*, 566–581. https://doi.org/10.1111/j.1467-7687.2010.01004.x